AMBIENT AIR QUALITY IN WINDSOR

Annual Report 1978

Ministry of the Environment
Ontario

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AMBIENT AIR QUALITY

IN

WINDSOR

Annual Report 1978

Technical Support Section

Southwestern Region

ONTARIO MINISTRY OF THE ENVIRONMENT

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SUMMARY

Quantitative data for pollutants in the ambient air show that although unsatisfactory levels still persisted for some pollutants during 1978, levels tended to be appreciably lower than in previous years. Criteria for suspended particulates continued to be exceeded in much of Windsor with particulate levels being higher in west Windsor, where the influence of emissions from the industrialized area of downriver Wayne County would tend to be most severe, and in the vicinity of the casting plant of Ford Motor Company of Canada, Limited, where a major abatement program is scheduled for 1979. The decreased levels of particulates were associated with an increased frequency of north-easterly winds, which would tend to bring less particulates into the Windsor area than winds from southerly and westerly directions.

Monitoring for sulphur dioxide in the Windsor area began during the 1960's and 1978 was the first year in which hourly, daily and annual criteria for desirable ambient air quality were met continuously.

Fluoridation rates above the criteria were much less frequent during 1978 than 1977 and levels were not high enough to have vegetation damage detected during phytotoxicology surveys. As for each year since 1972, the criteria for carbon monoxide were met continuously during 1978 while there was one excursion above the 1-hour criterion for nitrogen dioxide.

Similar to previous years, the 1-hour criterion for ozone was exceeded fairly frequently during the warmer months of the year with the highest frequencies of excursions being associated with southerly and south-south-westerly

winds. Ozone is formed by photochemical reactions involving local emissions of hydrocarbons and oxides of nitrogen as well as quantities of these precursor chemicals transported into Windsor from distant sources. Also, ozone is brought into the Windsor area by similar long range transport of air masses. Control of ozone will depend on strategies implemented in both the United States and Canada.

INTRODUCTION

The Ontario Ministry of the Environment operates a network of ambient air monitors to measure the levels of a number of pollutants that directly or indirectly may have adverse effects on health, vegetation or the enjoyment of property. Data on the levels of pollutants are compared with criteria for desirable ambient air quality, listed in The Environmental Protection Act, 1971. Furthermore, data are used to determine trends in air quality and therefore the effectiveness of pollution abatement, as well as to provide information on the effect of specific sources of pollutants and information critical to the development of strategies to control pollution.

In addition to the monitoring of ambient air described in this report the Ministry conducts phytotoxicology surveys to determine the effects of air pollutants on vegetation. Also, inventories of emissions are maintained and utilized in mathematical models to predict levels of pollutants in the atmosphere.

DESCRIPTION OF MONITORING NETWORK

At fixed sites throughout the Windsor area the Ministry operates continuous and intermittent ambient air monitors. Monitoring is more intensive in the downtown area, where emissions from automotice traffic and commercial establishments are most notable, and in west Windsor, which is the location of the J. C. Keith Generating Station of Ontario Hydro and is close to a heavily industrialized portion of Wayne County, Michigan.

During 1978 the monitoring network was modified to improve efficiency and to provide an improved quality of data. Six monitors for dustfall, one for total suspended particulates, six for sulphation rate and one for fluoridation rate were relocated to alternative nearby sites to reduce interferences from such influences as road construction and trees. Six samplers used to determine the soiling index for 2-hour periods were removed since the data they provided were not compatible with the samplers providing the soiling index used to determine the Air Pollution Index (API) for Windsor.

The locations of the Ministry's monitoring stations in the Windsor area are illustrated in Appendix 1, Figure 1 and are described in Table 1 of the same Appendix. The pollutants monitored at the various stations are shown in Table 2. Table 3 indicates Ontario's criteria for desirable ambient air quality with respect to the pollutants monitored as well as the prime basis for establishing these criteria.

Ontario Hydro operated five monitors for sulphur dioxide at sites located in different directions from the J. C. Keith Generating Station at distances ranging from 5 to 7 kilometres. Data obtained by Ontario Hydro are not included in this report but have been utilized as a check on the quality of the Ministry's data and to locate sources of pollution.

METEOROLOGICAL DATA

Meteorological data are obtained from the Ministry's stations 12032 and 12034. At station 12032, located in the Morton Dock area of west Windsor, wind speed and direction are measured at levels 7 metres and 30 metres above ground.

At station 12034, located close to downtown Windsor and the Detroit River, data are collected for wind speed and direction at 10-metre and 46-metre levels as well as ambient temperature at the 10-metre level and the difference in ambient temperatures between the two levels.

The data collected at these stations are used to forecast meteorological conditions in association with the Air Pollution Index. Also, data are correlated with other pollutants such as suspended particulates, sulphur dioxide and ozone to determine sources of pollutants.

A summary of meteorological data collected from 1972 through 1977 at station 12032 and data for 1976 to 1978 from station 12034 appears in Appendix 2, Table 4. Because of monitoring problems at station 12032 much of the data for 1978 were lost. The role that the increased frequency of north-easterly winds played on the levels of pollutants during 1978 is discussed in later sections of the report.

PARTICULATES

The iron and steel industry, foundries, power generating plants utilizing fossil fuels and road traffic are primary sources of particulates that adversely affect air quality in Windsor. Wind-blown particulates from open fields, sand and coal piles, roadways and roofs are also significant sources.

Measurements for particulates are reported as suspended particulates, dustfall and soiling index. Levels of suspended particulates are determined by drawing measured volumes of air through a filter for 24 hours and subsequently

weighing the quantity of particulates collected on the filter. Dustfall is measured by exposing open cylinders (jars) of known diameter for 30 days and subsequently weighing the amount of particulates collected in the jar. Dustfall loadings are expressed in grams per square metre per 30 days (gm/m^2/30 days).

Soiling index is determined by measuring the difference in the amount of light transmitted through a filter before and after ambient air is drawn through the filter for periods of 1 or 2 hours. The amount of light transmitted through the filter is affected by the quantity, size, shape and opaqueness of particles retained on the filter. Light transmitted through the filter is measured by a photoelectric cell and the soiling index may be calculated immediately. This immediate availability of the soiling index in contrast to the time-consuming laboratory analysis required for total suspended particulates has resulted in the soiling index being used in the Air Pollution Index as an indicator of levels of suspended particulates.

SUSPENDED PARTICULATES

Two criteria for desirable ambient air quality exist for suspended particulates. One is 120 micrograms of suspended particulates per cubic metre of air (ug/m^3) averaged over a 24-hour period. The other is an annual geometric mean of 60 ug/m^3. The criterion for 24 hours is based on impairment of visibility and adverse health effects associated with combined concentrations of sulphur dioxide and suspended particulates. The annual criterion is based on public awareness of suspended particulates and property damage.

During 1978 filters were exposed to collect suspended particulates at 13 sites in the Windsor area on a sampling frequency of every sixth day. The 24-hour criterion was exceeded at all sites, with the frequencies of excursions ranging from 4 to 40 percent. The annual criterion was exceeded at 9 of the 11 sites where sufficient numbers of samples were collected to compute representative geometric means. A summary is presented in Appendix 3, Table 5.

Figure 2, Appendix 3, which contains a bar graph of the average of the annual geometric means for eight stations common to the years 1972 through 1978, illustrates the improvement in levels of particulates since 1972. Also included in Figure 2 is a bar graph of the average frequencies of excursions above the 24-hour criterion for the same 8 stations from 1972 through 1978.

During 1978 there was a greater frequency of north-easterly winds and a lower frequency of winds blowing particulates from sources in Wayne County towards Windsor than in previous years. These more favourable wind conditions may have accounted for part of the reduction in average levels of particulates during 1978.

The annual geometric mean and the frequency of excursions above the 24-hour criterion were greatest at station 12013, located near the casting plant of Ford Motor Company of Canada, Limited. Additional control facilities are scheduled to be installed at the casting plant in 1979 which should improve ambient air quality, although achievement of the criteria for desirable ambient air quality is not anticipated to result from these improvements since other sources affect this station.

A sufficient quantity of data for suspended particulates for 1978 was available at 11 monitoring sites to permit correlation with data for wind direction from station 12034, located on Riverside Drive, close to downtown Windsor. The correlations are presented in Figure 3 of Appendix 3 with the longer lines indicating higher correlations. These correlations indicate that at all monitoring stations higher levels of suspended particulates were associated with south-westerly winds, the direction from which appreciable quantities of particulates are contributed by sources in the United States. For some stations there are strong correlations between suspended particulates and other wind directions. The correlations depicted at station 12015 for winds from west-north-west to west-south-west indicate the influence of the many sources of suspended particulates in the environs of Zug Island, Wayne County, Michigan.

The influence of emission sources located in the heavily industrialized portion of Wayne County across from west Windsor is also apparent from the higher annual geometric means and frequencies of excursions above the 24-hour criterion experienced at west Windsor stations compared to east Windsor stations. Figure 4 of Appendix 3 serves to illustrate the elevated values in west Windsor as well as the elevated results for station 12013 (annual geometric mean of 100 ug/m^3, 40% above 24-hour criterion) which is affected by emissions from the casting plant of Ford Motor Company of Canada, Limited.

Chemical Analysis of Suspended Particulates

As part of a Province-wide study, samples of suspended particulates collected at 7 stations in Windsor were analyzed quantitatively for cadmium, chromium, copper,

iron, lead, manganese, nickel, nitrates, sulphates and vanadium. A summary of these data collected from 1976 through 1978, is contained in Appendix 3, Table 6.

Criteria for desirable ambient air quality exist for cadmium, lead, nickel and vanadium. Concentrations of the various metals have been low with no values above the criteria. There is no apparent trend of increasing levels of metals in suspended particulates.

DUSTFALL

The criteria for desirable ambient air quality established for dustfall are a 30-day loading of 7.0 grams of dustfall per square metre (g/m^2/30 days) and an annual average of 4.6 g/m^2/30 days. These criteria were established on the basis of historical data and standards developed by other enforcement agencies.

During 1978 the criteria were exceeded at monitoring stations located in the proximity of the Detroit River while at stations located further inland (south of Tecumseh Road) the criteria were met or only marginally exceeded. Figure 5, Appendix 3 shows the annual averages for dustfall and the frequencies of excursions above the 30-day criterion as determined for the different stations monitored during 1978. Sources of particulates located in Wayne County, Michigan, as well as sources related to the industrial and downtown commercial activities of Windsor adjacent to the Detroit River would contribute to the criteria for dustfall being exceeded.

The 1978 loadings for dustfall and the percentage of values greater than the 30-day criterion appear in Table 7, Appendix 3. Figure 6, illustrates the trend of gradually

lower loadings of dustfall and frequencies of excursions above the 30-day criterion for data averaged from 14 monitoring sites that operated from 1972 through 1978.

SULPHUR OXIDES

The predominant source of man-made emissions of sulphur oxides is the combustion of sulphur-containing fuels. Therefore, primary emitters of sulphur oxides are power plants and industries utilizing fossil fuels to meet requirements for large amounts of energy.

During 1978 sulphur oxides were measured in Windsor as gaseous sulphur dioxide, sulphation rate and sulphate in suspended particulate matter. Continuous measurements of gaseous sulphur dioxide were made with analyzers utilizing coulometric technology. Sulphation rate is a measurement of sulphur compounds oxidized to lead sulphate after contact with plates of lead peroxide exposed for monthly periods. Data for sulphate in suspended particulates are presented in the summary table related to the section on the Chemical Analysis of Suspended Particulates.

SULPHUR DIOXIDE

During 1978 gaseous sulphur dioxide was measured continuously by the Ministry of the Environment at five fixed locations in west, east and downtown Windsor. Data are reported as average concentrations for periods of 1 hour, 24 hours (midnight-to-midnight) and 1 year (annual). The criteria for desirable ambient air quality are 0.25 parts of sulphur dioxide per million parts of air (ppm) for 1 hour, 0.10 ppm for 24 hours, and an annual average of 0.02 ppm. The 1-hour and annual criteria were established for the protection of vegetation while the 24-hour criterion serves to protect human health.

For the first time since the Ontario Government started this type of monitoring at Windsor in 1968, the data for 1978 from all monitors met the criteria for desirable ambient air quality. A summary of 1978 data for sulphur dioxide is presented in Appendix 4, Table 8. Figure 7 graphically displays the trend of decreasing levels of sulphur dioxide for stations 12008 and 12032 since 1972. The improvement in levels of sulphur dioxide is attributable to better control and dispersion of emissions of sulphur dioxide in Wayne County, Michigan and Windsor.

Pollution roses for sulphur dioxide at each station are presented in Figure 8, Appendix 4. The roses were developed by determining the average concentrations of sulphur dioxide that corresponded to 16 wind directions. Data for wind direction were measured at the 46-metre level of station 12034. The pollution roses indicate an influence of sources of sulphur dioxide located in Wayne County, Michigan, but these were not sufficient to deteriorate air quality above the desirable criteria.

SULPHATION RATE

The criterion for desirable ambient air quality with respect to sulphation rate is 0.7 milligrams of sulphur trioxide per 100 square centimetres of lead peroxide filter per day (mg $SO_3/100cm^2/day$), based on an exposure of the filter to ambient air for approximately 30 days. This criterion was developed for the protection of vegetation from correlations between sulphation rate and levels of sulphur dioxide that would protect vegetation. Recent studies by the Ministry of the Environment have shown large differences in correlations from site to site such that the criterion for sulphation rate does not necessarily reflect levels of sulphur dioxide that protect vegetation. Consequent-

ly, it is the intention of this Ministry to replace the criterion for desirable ambient air quality established for sulphation rate with a guideline which, if exceeded, will lead to consideration of installing a monitor for gaseous sulphur dioxide. In the Windsor area the network of monitors for sulphur dioxide is sufficient to define air quality without measurements for sulphation rate and consequently sulphation rate measurements were terminated after 1978.

Data for 1978 are presented in Appendix 4, Table 9.

AIR POLLUTION INDEX

The Air Pollution Index (API) is a system designed to control or prevent an air pollution episode. Meteorological forecasting and readings of sulphur dioxide and suspended particulates are utilized to predict the potential for the persistence of high pollution conditions that are numerically reported as the API.

Data for suspended particulates are provided by the measurement of soiling index and a correlation between concentrations of suspended particulates and soiling index. Hourly values of soiling index and gaseous sulphur dioxide are inserted in the following equation:

$$\text{1-hour API} = 0.78\ (18.26\ \text{COH} + 156.7\ SO_2)^{1.06}$$

where: COH is soiling index expressed in co-efficient of haze units.

SO_2 is sulphur dioxide expressed in parts per million.

The 1-hour API is used to determine a running average for 24 hours which is reported as the official API.

API values up to 32 are considered acceptable. Values from 32 to 49 are at the Advisory Level and if adverse weather conditions are likely to persist, contributors of major emissions are advised to prepare to curtail operations. At an API of 50 major emitters may be ordered to curtail operations. At 75, further cutbacks can be required. When the API reaches 100 all industries and other contributors of pollution not essential to public health and safety may be ordered to cease operations.

Although the API is based on the control of combined levels of sulphur dioxide and suspended particulates, emissions of other pollutants are controlled simultaneously. However, situations may occur where levels of certain pollutants such as ozone are high and the API may be in the acceptable range. These conditions would be detected by the normal monitoring program of the Ministry.

Levels of soiling index and sulphur dioxide for the computation of two separate API's are made at station 12008, in downtown Windsor and station 12016 in west Windsor. Meteorological data are provided by station 12034 on Riverside Drive. During 1978 the API did not exceed the acceptable range at station 12016, while at station 12008 it was exceeded on one occasion when it reached the Advisory Level for 33 hours and exhibited a maximum value of 38.

CARBON MONOXIDE

Combustion processes represent man's major emissions of carbon monoxide. Emissions from motor vehicles are especially significant because they occur near ground level and are concentrated in urban areas where the public may be

exposed for long periods. Industries and power generating plants normally provide adequate dispersion for their emissions to prevent unsatisfactory levels of carbon monoxide in the ambient air.

The criteria for carbon monoxide are 30 ppm for 1 hour and 13 ppm for any consecutive 8-hour period. These criteria were established for the protection of human health and were not exceeded during 1978, based on monitoring at station 12008. Since this site is located in the downtown area of Windsor where the highest levels of carbon monoxide are expected, there is a high probability that levels were acceptable throughout the Windsor area.

A summary of data for carbon monoxide, obtained since 1972, is presented in Appendix 5, Table 10. Data obtained from 1972 to 1976 are higher than data for the last two years, attributable to a less accurate monitoring capability which was resolved with the installation of a more sophisticated monitor for carbon monoxide late in 1976.

OXIDES OF NITROGEN

Like many other pollutants, oxides of nitrogen are emitted into the atmosphere by man through combustion processes. Nitric oxide and nitrogen dioxide are the compounds of primary interest.

Criteria for desirable ambient air quality exist for nitrogen dioxide, but not for nitric oxide or total oxides of nitrogen. The criteria, which are based on the protection of human health and offensive odours, are 0.20 ppm averaged for 1 hour and 0.10 ppm averaged for 24 hours.

During 1978 the criterion for 1 hour was marginally exceeded on one occasion (0.21 ppm) while the criterion for 24 hours was met continuously. The data were determined by a continuous monitor located at station 12008 in downtown Windsor where emissions from motor vehicles would be concentrated.

The summary of data for oxides of nitrogen, presented in Appendix 5, Table 10, indicates relatively consistent levels of the compounds since 1974.

Although criteria for nitrogen dioxide have been exceeded for only 1 hour since 1973, oxides of nitrogen contribute to the formation of unsatisfactory levels of air pollution through their roles in the formation of photochemical oxidants. Therefore consideration is being given to further controlling levels of oxides of nitrogen.

HYDROCARBONS

The principle man-made source of hydrocarbons is emissions from motor vehicles. Other significant man-made sources are incomplete combustion of fuels by industries and power plants and evaporation losses during the storage and transportation of hydrocarbons. Natural phenomena also produce many hydrocarbons of which methane is the most abundant.

Owing to the wide range of effects associated with different hydrocarbons at various concentrations, no desirable ambient air criteria have been established for total hydrocarbons. Instead, control is achieved by setting criteria for desirable levels of specific hydrocarbons in ambient air and/or establishing standards which control the impact of emissions of specific hydrocarbons.

Although there are no criteria for total hydrocarbons, monitoring for total hydrocarbons provides information on trends in the levels of hydrocarbons. Increasing levels of hydrocarbons could be significant should they be due to detrimental compounds.

Total hydrocarbons are monitored continuously at station 12008 in downtown Windsor, using flame ionization detection. Annual averages of total hydrocarbon concentrations, listed in Appendix 5, Table 10 fluctuated in a range from 1.9 to 2.6 ppm for the years 1972 to 1978. This range of annual averages is similar to levels detected in downtown areas of other cities and a trend of increasing levels is not apparent.

OXIDANTS

Oxidants in the ambient air are primarily a result of a series of photochemical reactions and inter-reactions involving oxides of nitrogen and hydrocarbons. The reactions are promoted by certain meteorological conditions such as warm temperatures and intense sunshine that result in higher levels of oxidants in the spring and summer months.

The Ministry of the Environment measures oxidants in the form of ozone at station 12008, located in downtown Windsor. Ozone normally accounts for 80 to 95 per cent of the oxidants present in ambient air. Technology for monitoring ozone is more accurate and efficient than that for total oxidants and therefore most regulatory agencies monitor for ozone.

Long range transport of ozone and its precursor chemicals (oxides of nitrogen and hydrocarbons) may account for a very significant portion of local levels of ozone. Long-range transport from distances greater than 200 kilometres has been reported in the literature. Consequently, successful control of oxidants will depend on control strategies implemented in the United States as well as in Ontario.

Ozone is also present in the stratosphere where it plays the critical role of absorbing excessive amounts of ultraviolet solar radiation that may be biologically harmful. Occasionally, ozone from the stratosphere may be transported downward to cause elevated concentrations at the earth's surface. Ozone is naturally produced in minor amounts by lightning.

The criterion for desirable ambient air quality established for ozone is 80 parts per billion (ppb) averaged for 1 hour. This criterion was established for the protection of vegetation and human health. Some effects detrimental to health that are associated with oxidants are eye irritation and a decrease in the performance of athletes.

During 1978 the criterion was exceeded on 201 occasions with all but 5 of the 201 elevated levels being recorded in the months May through September. An investigation of the relationship between elevated levels of ozone and wind speed and direction revealed that 77 per cent of the excursions above 80 ppm occurred with wind from the south-south-west, south, east-north-east or calm conditions. A pollution rose, associating the frequency of ozone values above 80 ppm with wind speed and direction, appears in Appendix 5, Figure 9. Table 10, Appendix 5, contains a summary of ozone data from 1974 through 1978.

In Ontario there has been no documentation of adverse health effects attributed to ozone encountered in the natural environment. However, there is extensive documentation of damage to vegetation, especially to crops such as grapes, tobacco and beans.

FLUORIDES

Sources of fluorides in the Windsor area are the steel industry located in the downriver area of Wayne County, Michigan, power plants where coal burned contains trace amounts of fluorides, fluorospar unloading operations at docks in west Windsor and subsequent trucking of fluorospar from the docks to a location south of Windsor.

Fluoridation rate is a measurement designed to indicate the relative amount of gaseous fluoride present over an extended period of time. A lime-impregnated filter is exposed to ambient air for thirty days and then analyzed for fluoride content. This technique is relatively inexpensive in contrast with other methods for measuring airborne fluoride. Some fluorides in particulate form are collected on the filter.

The criteria for desirable ambient air quality established for fluoridation rate are based on the protection of vegetation. Consequently, there is a criterion established for the growing season from April 15 to October 15 which is 40 micrograms of fluoride per 100 square centimetres of filter per 30 days (ugF/100cm^2/30days) as well as a criterion of 80 ugF/100cm^2/30 days for the period October 16 to April 14. Since the months of April and October are common to

both criteria and fluoridation rate is determined on a monthly basis, excursions above the criteria during these months are determined by comparing the fluoridation rate to the average of the two criteria (60 ugF/100cm^2/30 days).

Data for 1978 fluoridation rates which appear in Appendix 6, Table 11, show that the west Windsor area near the Morton Dock experiences the greatest number of excursions above the criteria. Figure 10 of the same Appendix also shows that higher levels are experienced in west Windsor. Although the criteria were periodically exceeded, phytotoxicology surveys revealed no vegetation damage attributable to fluorides in the Windsor area.

The levels of fluoridation rate and the frequency of values above the criteria during 1978 were much less than 1977 and although fluoridation rate is not considered a sensitive indicator of temporal trends of fluoride the magnitude of the decrease indicates improved air quality. Some of the improvement may be attributed to winds blowing less frequently from locations in Wayne County where significant sources exist and from the direction of unloading operations at the Morton Dock. Figure 11, Appendix 6, contains a summary of data on fluoridation rate from 1972 through 1978.

APPENDIX I

DESCRIPTION OF MONITORING NETWORK

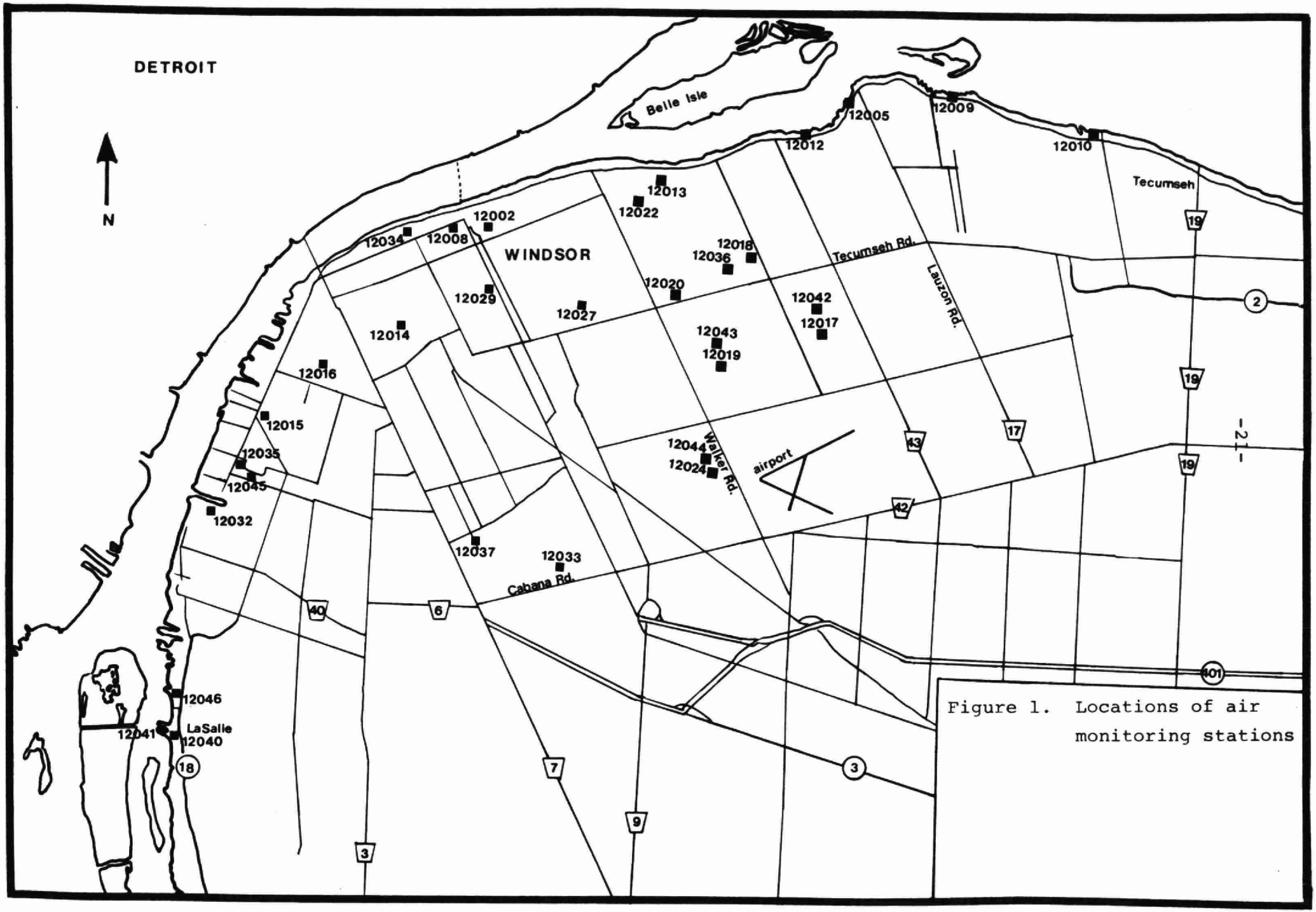


Figure 1. Locations of air monitoring stations

Table 1. Locations of air monitoring stations

Station number	Location	Universal transverse mercator projection co-ordinates	Elevation above sea level (metres)	Air intake height (metres)
12002	444 Windsor Avenue, City Hall	03323 - 46867	183	17
12005	7730 Riverside Drive East	03395 - 46890	177	10
12008	467 University Avenue	03316 - 46867	183	12
12009	Tecumseh Water Works	03413 - 46888	180	2
12010	Tecumseh Sewage Pumping Station	03460 - 46875	181	1
12012	7007 Riverside Drive East	03385 - 46882	176	4
12013	3665 Wyandotte Street East	03358 - 46874	185	7 & 10
12014	College/California Street	03304 - 46849	185	1
12015	Highway No. 18/Prospect	03283 - 46833	175	6
12016	College/South Street	03290 - 46841	175	4
12017	5066 Joinville Street	03388 - 46850	183	5
12018	W. P. Herman Collegiate	03372 - 46858	183	5
12019	Somme/Alexis Street	03369 - 46842	183	5
12020	1869 Albert Street	03363 - 46854	183	5
12022	Hickory/Richmond Street	03352 - 46870	183	5
12024	Byng/Seymore Street	03369 - 46820	183	5
12027	1526 Parent Street	03340 - 46852	183	5
12029	459 Ellis West	03323 - 46853	185	5
12032	Morton Dock	03271 - 46817	175	4, 7 & 30
12033	3501 Longfellow	03335 - 46801	183	5
12034	C. P. Telecommunication Tower	03308 - 46868	175	10 & 46
12035	Healy/Sandwich	03276 - 46826	175	5
12036	1794 Westcott Street at Milloy Street	03367 - 46858	186	5
12037	3225 California Street (St. Hubert's School)	03327 - 46816	183	4
12040	225 Willow Drive (La Salle)	03261 - 46774	175	5
12041	170 Willow Drive (La Salle)	03263 - 46773	175	5
12042	Princess/Joinville Street	03384 - 46848	185	5
12043	Somme/Chandler	03366 - 46845	183	5
12044	Seymour/Turner	03366 - 46822	183	5
12045	Healy/Sandwich	03276 - 46822	183	5
12046	Adams/Hwy 18	03264 - 46778	175	5

Table 2. Parameters monitored in the ambient air in Windsor during 1978

Station Number	Air Pollution Index	Carbon Monoxide	Dustfall	Fluoridation Rate	Hydrocarbons	Meteorological Data	Nitric Oxide	Nitrogen Dioxide	Nitrogen Oxides	Ozone	Soiling Index (COH)	Sulphation Rate	Sulphur Dioxide	Suspended Particulate
12002			X								X	X		X
12005			X									X		X
12008	X	X	X	X	X		X	X	X	X	X	X	X	X
12009			X									X		X
12010			X								X	X		X
12012			X									X		X
12013			X								X	X	X	X
12014			X								X	X		X
12015			X	X							X	X	X	X
12016	X		X	X							X	X	X	X
12017												X		
12018												X		
12019			X									X		
12020			X									X		
12022			X	X								X		
12024			X									X		
12027			X	X								X		
12029			X									X		
12032			X	X		X					X	X	X	X
12033			X									X		
12034						X								
12035			X	X								X		
12036														X
12037														X
12040			X	X								X		
12041			X									X		
12042			X									X		
12043			X									X		
12044			X									X		
12045			X	X								X		
12046			X									X		

Table 3. Desirable ambient air quality criteria established by the Ontario Ministry of the Environment

Parameter	Desirable ambient air quality criteria	Prime reasons for establishing criteria or monitoring parameter
Carbon monoxide	30 ppm averaged for 1 hour 13 ppm averaged for 8 hours	Protection of human health Protection of human health
Dustfall	7 grams/metre^2 in 30 days 4.6 grams/metre^2 (monthly average in 1 year)	Historical and in keeping with other control agencies
Fluoridation rate	40 ug of fluorides/100cm^2 of limed filter paper in 30 days during April 15 to October 15	Protection of vegetation
	80 ug of fluorides/100 cm^2 of limed filter paper in 30 days during October 16 to April 14	Protection of vegetation (less restrictive criterion during the non growing season)
Hydrocarbons (total)	None	Effects of hydrocarbons vary widely depending on their chemical-physical nature
Nitric oxide	None	Reacts with oxygen to produce NO_2
Nitrogen dioxide	0.20 ppm averaged for 1 hour	Protection of human health and protection against odours
	0.10 ppm averaged for 24 hours	Protection of human health and protection against odours
Oxides of nitrogen	None	

Table 3. continued

Parameter	Desirable ambient air quality criteria	Prime reasons for establishing criteria or monitoring parameter
Ozone	0.08 ppm averaged for 1 hour	Protection of vegetation and human health
Sulphation rate	0.7 mg of SO_3 per 100 cm^2 of lead peroxide per day	Serves to measure relative amount of sulphur oxides over extensive periods of time thus permitting comparisons to annual average concentrations
Sulphur dioxide	0.25 ppm averaged for 1 hour	Protection of vegetation
	0.10 ppm averaged 1 day (24 hours)	Protection of human health
	0.02 ppm averaged for 1 year	Protection of vegetation
Suspended particulates	120 ug/m^3 averaged for 24 hours	Based on impairment of visibility and health effects
	60 ug/m^3 (geometric mean) during 1 year	Based on public awareness of visible pollution
Cadmium in suspended particulates	2.0 ug/m^3 averaged for 24 hours	Based on protection of human health
Lead in suspended particulates	5.0 ug/m^3 averaged for 24 hours	Based on protection of human health
	2.0 ug/m^3 as a geometric mean over a 30 day period	Based on protection of human health
Nickel in suspended particulates	2.0 ug/m^3 averaged for 24 hours	Based on protection of vegetation
Vanadium in suspended particulates	2.0 ug/m^3 averaged for 24 hours	Based on protection of human health

APPENDIX 2

METEOROLOGICAL DATA

Table 4. Summary of data for percent frequencies of wind direction.

Site and year	Wind directions							
	North	North-east	East	South-east	South	South-west	West	North-west
Station 12032: 30-metre level								
1972	9.0	11.2	11.3	8.6	15.9	15.0	14.7	14.3
1973	13.0	10.7	11.2	7.8	11.8	19.2	13.9	12.3
1974	7.3	10.3	8.5	7.0	22.5	16.7	14.6	13.0
1975	6.8	10.6	10.6	8.1	16.6	19.4	15.6	12.3
1976	9.7	8.8	8.3	7.2	14.5	16.2	20.2	15.1
1977	8.8	10.1	8.6	9.9	16.4	20.8	16.0	9.5
Station 12034: 46-metre level								
1976	8.1	11.3	6.7	3.8	14.0	21.1	20.2	14.8
1977	4.2	12.0	9.4	6.7	16.7	20.4	18.7	12.0
1978	8.7	17.8	7.8	5.7	12.8	19.5	14.0	13.8

APPENDIX 3

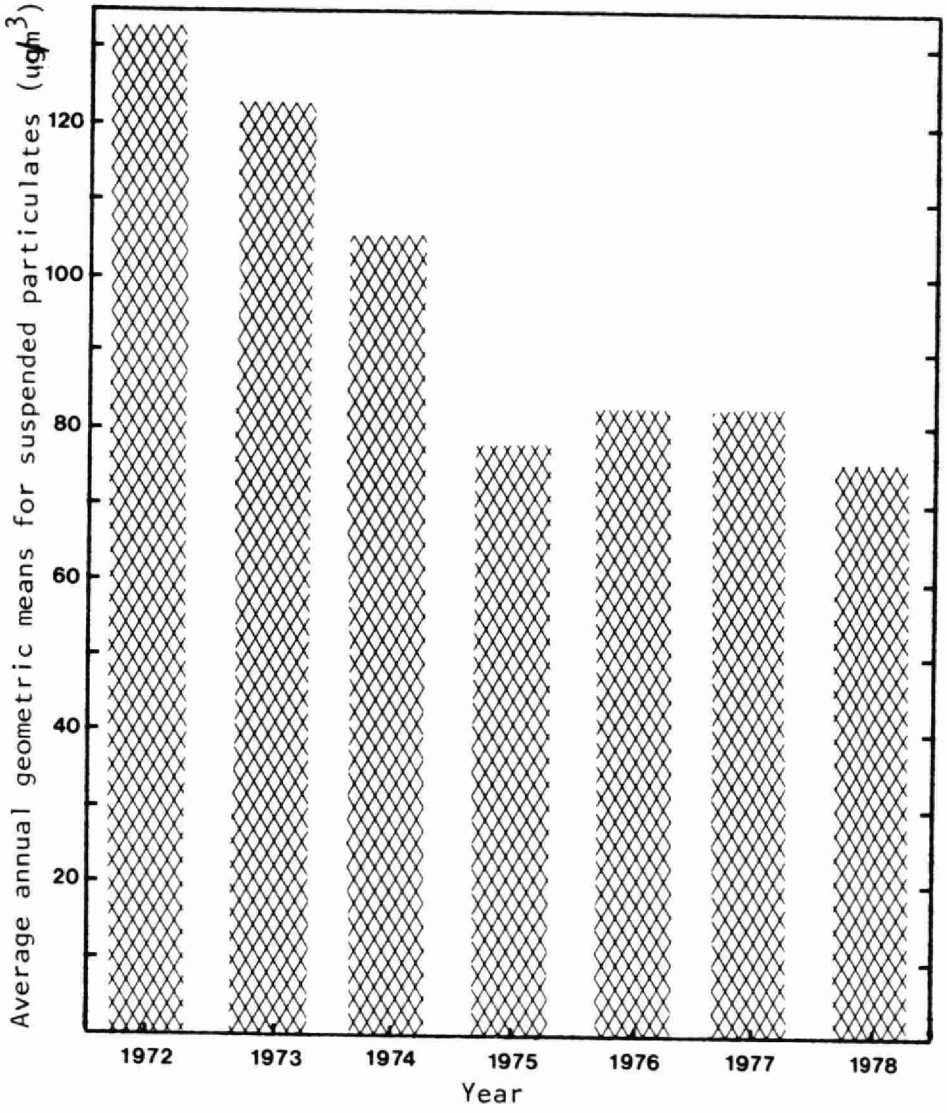
PARTICULATES

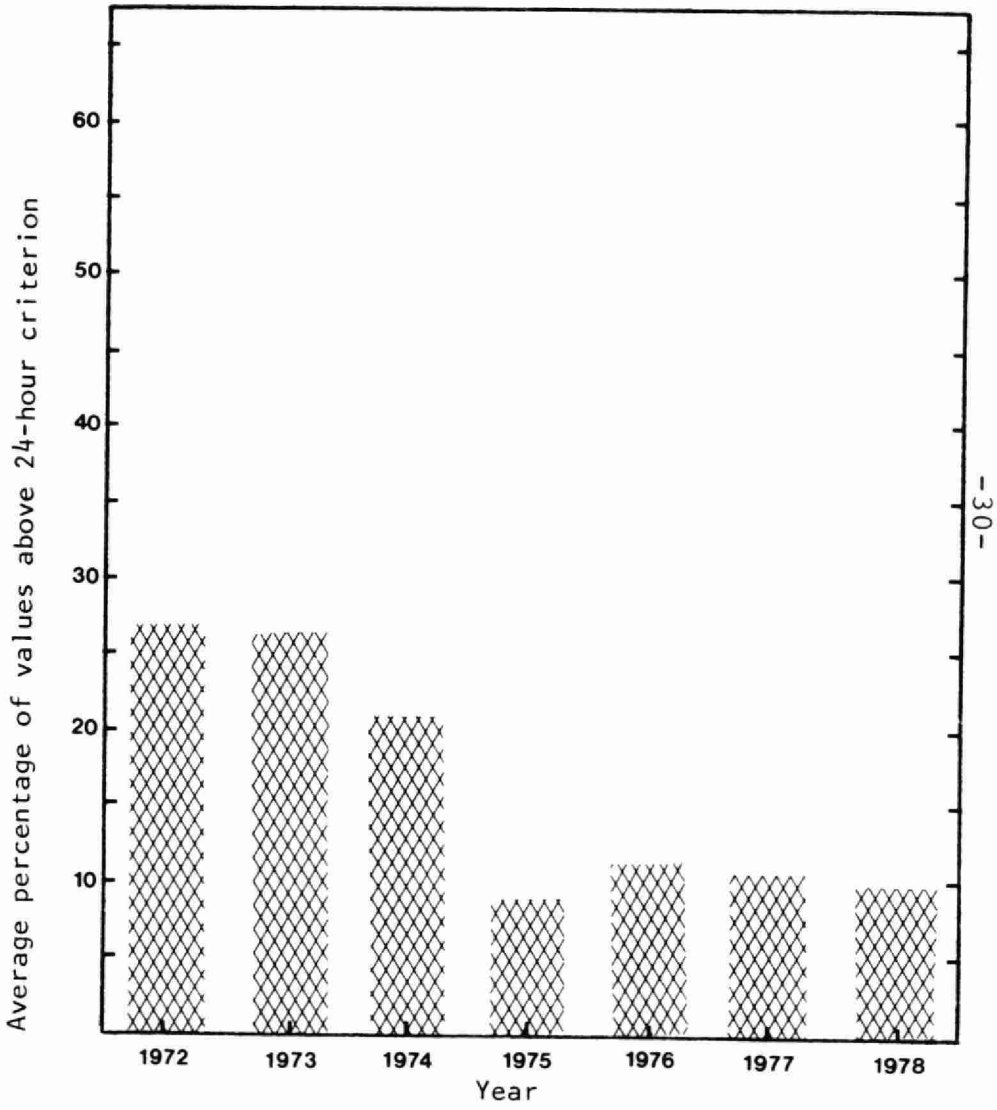
Table 5. Summary of data for total suspended particulates.

Station	Year						
	1972	1973	1974	1975	1976	1977	1978
	Annual geometric means (ug/m^3)						
12002	159	133	108	74	76	82	79
12005							I.D.
12008	126	126	116	82	80	87	80
12009	79	82	61	52	58	54	52
12010	85	86	58	46	54	47	46
12012	100	87	84	79	65	72	I.D.
12013	151	145	113	89	98	113	100
12014	152	148	139	95	94	96	77
12015	183	147	152	105	113	93	93
12016				88	88	95	84
12032	126	120	94	81	89	93	79
12036						72	63
12037						67	68
	Percentage of values above 24-hour criterion						
12002	70	58	43	14	15	21	18
12005							4
12008	57	55	47	17	19	24	16
12009	16	25	10	2	5	7	9
12010	23	27	17	2	10	6	7
12012	43	36	27	17	11	16	5
12013	65	69	44	26	37	40	40
12014	70	72	64	25	26	26	20
12015	80	66	84	33	42	25	27
12016				20	24	22	23
12032	53	53	30	21	27	25	19
12036						11	9
12037						10	15

I.D. - Insufficient data to compute a representative geometric mean.

Figure 2. Trend in levels of suspended particulates based on averaged data from eight monitoring stations





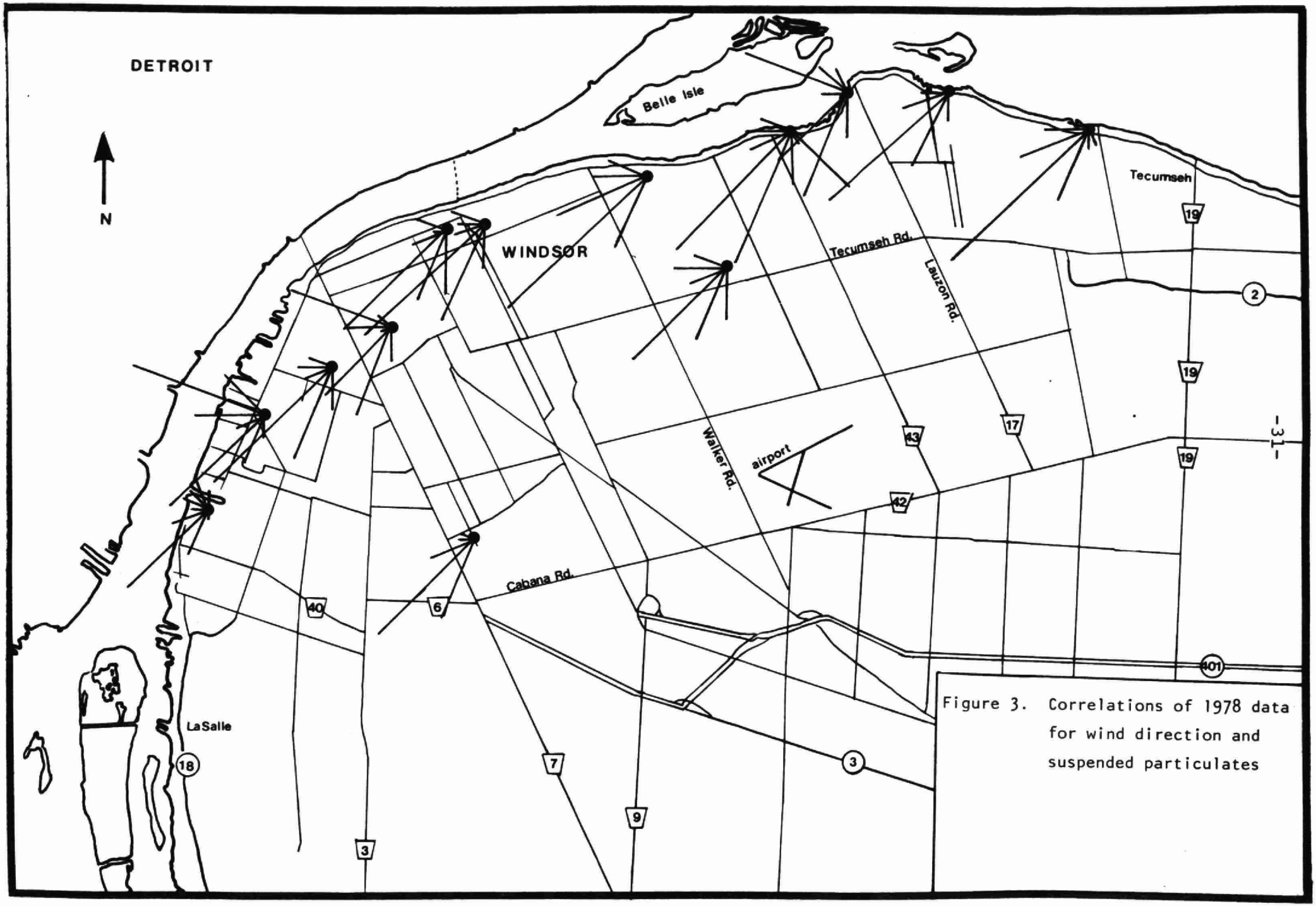


Figure 3. Correlations of 1978 data for wind direction and suspended particulates

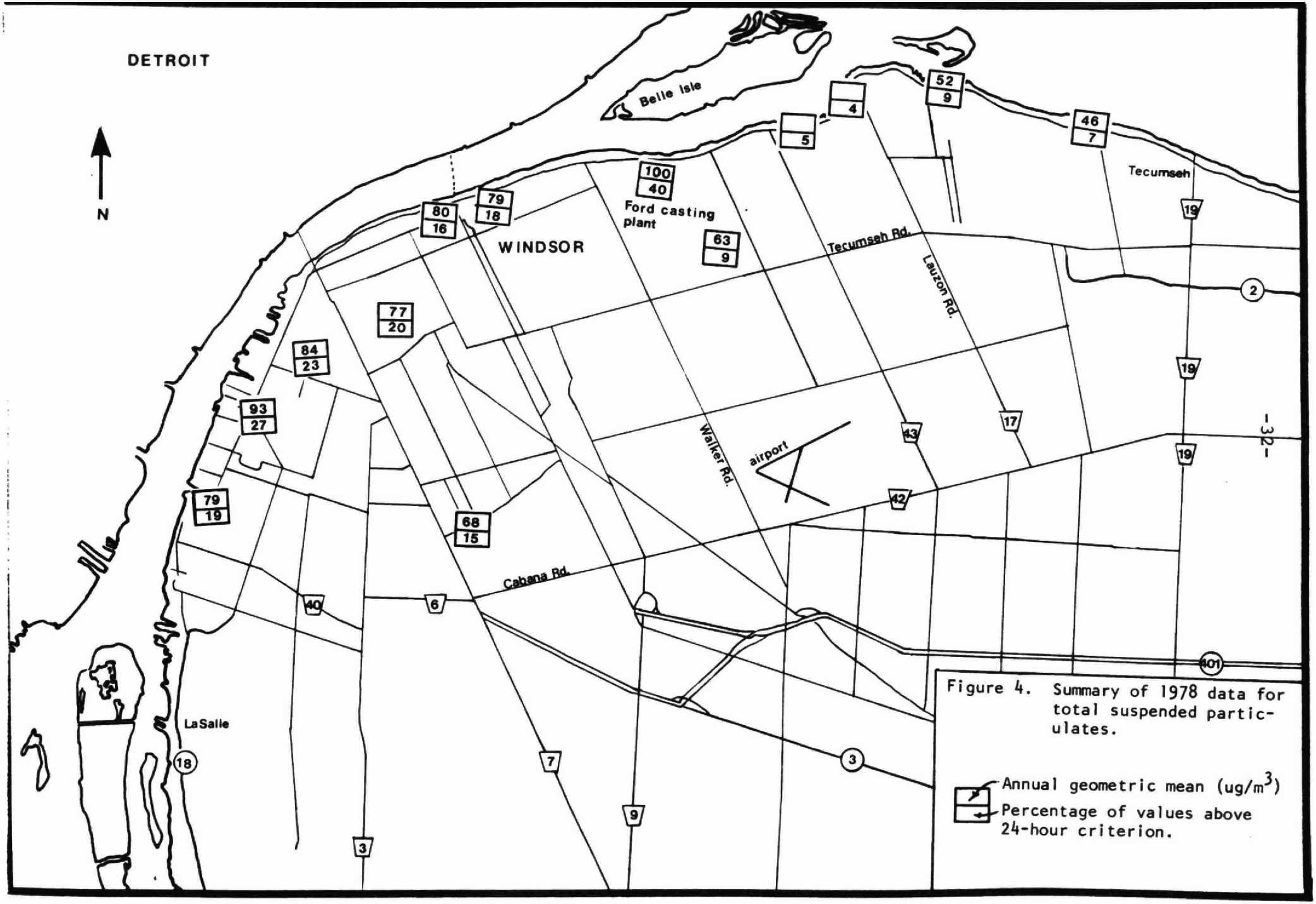


Figure 4. Summary of 1978 data for total suspended particulates.

Annual geometric mean (ug/m^3)

Percentage of values above 24-hour criterion.

Table 6: Summary of constituents in suspended particulate matter ($\mu g/m^3$)

	12002			12008			12010			12013			12014	12015	12017		12032	
	1978	1977	1976	1978	1977	1976	1978	1977	1976	1978	1977	1976	1978	1978	1978	1978	1977	1976
Cadmium																		
No. of samples	24	20	12	23	18	15	24	20	12	23	19	17				24	26	15
Average concentration	0.007	0.006	0.002	0.004	0.007	0.000	0.002	0.001	0.001	0.003	0.007	0.006				0.003	0.002	0.004
Maximum concentration	0.035	0.016	0.010	0.019	0.025	0.003	0.007	0.006	0.006	0.012	0.033	0.035				0.012	0.009	0.011
Chromium																		
No. of samples	24	20	12	23	18	15	24	20	12	23	19	17				24	26	15
Average concentration	0.018	0.031	0.006	0.017	0.017	0.012	0.007	0.009	0.007	0.032	0.032	0.028				0.021	0.015	0.012
Maximum concentration	0.045	0.062	0.022	0.045	0.074	0.029	0.020	0.029	0.026	0.116	0.101	0.113				0.056	0.048	0.028
Copper																		
No. of samples	24	20	12	23	18	15	24	20	12	23	19	17				24	26	15
Average concentration	0.23	0.15	0.10	1.13	0.42	0.25	0.13	0.08	0.12	0.09	0.14	0.14				0.14	0.34	0.10
Maximum concentration	0.62	0.52	0.36	2.55	1.07	0.45	0.44	0.24	0.31	0.26	0.35	0.28				1.00	1.13	0.37
Iron																		
No. of samples	24	20	12	23	18	15	24	20	12	57	24	22	47	55	56	52	29	40
Average concentration	3.1	3.0	3.3	2.8	3.9	3.2	1.0	1.1	1.6	5.7	7.2	5.7	2.7	4.0	3.8	2.9	3.5	4.1
Maximum concentration	9.9	8.4	8.2	7.8	11.1	6.9	2.5	5.5	5.2	20.6	26.3	21.9	8.2	15.4	12.5	9.6	17.9	8.4
Lead																		
No. of samples	24	21	12	23	18	15	24	20	12	23	19	17				24	26	15
Average concentration	0.6	0.7	0.7	0.6	0.8	0.6	0.3	0.3	0.3	0.5	0.7	0.6				0.4	0.4	0.4
Maximum concentration	1.2	1.3	1.1	1.8	1.7	1.3	1.2	0.9	1.0	1.0	1.8	2.0				0.9	0.9	1.3
Manganese																		
No. of samples	24	20	12	23	18	15	24	20	12	23	19	17				24	26	15
Average concentration	0.14	0.10	0.12	0.11	0.19	0.11	0.03	0.03	0.05	0.24	0.39	0.38				0.13	0.11	0.14
Maximum concentration	1.10	0.32	0.22	0.31	0.48	0.28	0.09	0.20	0.19	0.95	2.02	1.94				0.44	0.62	0.22
Nickel																		
No. of samples	24	20	12	23	18	15	24	20	12	23	19	17				24	26	15
Average concentration	0.016	0.025	0.012	0.026	0.026	0.050	0.008	0.019	0.003	0.013	0.030	0.004				0.008	0.015	0.001
Maximum concentration	0.034	0.073	0.027	0.059	0.084	0.409	0.019	0.035	0.021	0.058	0.069	0.029				0.031	0.060	0.005
Nitrate																		
No. of samples	52	56	54	55	48	105	55	52	51	56	64	59				50	61	65
Average concentration	6.2	4.8	4.9	5.3	5.1	4.8	4.5	4.3	3.5	6.5	6.1	4.4				5.1	6.2	5.1
Maximum concentration	20.5	21.6	11.8	20.5	23.5	21.6	25.2	24.5	14.2	22.8	32.0	15.0				17.8	32.0	31.3
Sulphate																		
No. of samples	52	56	54	55	48	104	55	52	51	56	54	59				50	61	65
Average concentration	14.0	12.4	9.4	14.3	13.3	10.6	11.5	10.3	6.9	14.7	13.0	8.2				13.5	15.2	10.9
Maximum concentration	41.1	35.5	35.1	57.1	34.2	39.7	44.1	25.4	31.9	48.4	33.6	21.0				45.3	35.0	55.6
Vanadium																		
No. of samples	24	20	12	23	18	15	24	20	12	23	19	17				24	26	15
Average concentration	0.00	0.03	0.02	0.00	0.02	0.17	0.00	0.00	0.00	0.00	0.01	0.00				0.00	0.01	0.01
Maximum concentration	0.02	0.14	0.03	0.03	0.10	1.47	0.00	0.02	0.01	0.03	0.07	0.02				0.03	0.06	0.03

Table 7. Levels of dustfall during 1978

Station number	Dustfall loading (g/m^2/30 days)													Percentage of values greater than monthly criterion
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual average	
12002	3.1	5.3	11.8	9.8	10.7	8.5	7.8	6.7	7.2	7.1	3.7	6.1	7.3	58
12005								3.1	3.4	3.3	2.7	4.3	(3.4)	0
12008	2.1	3.3	9.1	7.8	7.7	6.7	14.4	5.0	7.0	6.4	4.5	7.4	6.8	42
12009	1.1	2.0	5.0	3.8	6.5	7.2	9.9	2.8	3.1	3.3	2.9	2.7	4.2	17
12010	1.1	1.3	2.8	3.0	6.4	22.7	27.1	8.6	3.0	3.0	1.9	3.0	7.0	25
12012	0.9	2.8	5.4	5.4			10.6						(5.0)	20
12013	4.7	5.7	10.1	5.6	10.2	6.2	10.6	11.1	10.0	8.6	7.4	15.7	8.8	67
12014	2.9	5.9	9.9	5.9	10.3	8.9	6.1	6.6	7.5	9.5	7.3	10.0	7.6	58
12015	7.5	3.8	13.4	7.2	10.9	8.5	9.1	6.4	7.8	8.9	8.2	14.1	8.8	83
12016	4.1	2.9	6.5	6.5	8.5	5.9	6.8	6.0	9.6	6.6	5.8	7.0	6.4	17
12017	2.1	1.2	6.4										(3.2)	0
12019	0.9	1.9	7.0										(3.3)	0
12020	2.3	3.0	7.0	14.5	11.3	6.0	6.6	4.0	5.4	6.3	4.7	5.4	6.4	17
12022	4.1	5.6	15.0	12.9	12.7	11.0	12.0	7.9	8.2	8.4	7.4	9.6	9.6	83
12024	1.3	1.5	6.8										(3.2)	0
12027	4.3	5.5	20.3	11.7	12.8	9.5	9.5	6.8	6.4	10.3	18.5	11.8	10.6	67
12029	3.1	2.1	7.7	17.5	8.0	5.8	5.8	4.8	6.3	5.7	5.2	4.2	6.4	25
12032	3.3	2.0	5.9	6.1	23.5	18.0	5.4	6.0	6.4	6.3	6.0	5.8	7.9	17
12033	4.2	1.9	4.9	2.9	7.0	5.6	4.9	3.3	5.3	5.4	3.5	2.6	4.3	0
12035	6.2	5.9	10.7										(7.6)	33
12040	3.1	3.5	6.4	9.0	17.1	8.6	6.8	5.3	8.8	10.8	5.0	3.2	7.3	42
12041	3.5	2.8	5.1										(3.8)	0
12042				4.5	6.4	4.9	4.5	3.1	4.1	4.8	4.1	5.4	(4.6)	0
12043				5.0	7.0	4.7	4.1	3.4	3.7	6.4	3.8	3.6	(4.7)	0
12044					5.2	7.0	5.6	4.7	3.7	4.3	4.4	2.9	(4.7)	0
12045					16.7	12.6	6.6	6.0	6.5	7.5	3.4	3.5	(7.9)	38
12046				6.9	4.6	9.1	13.3	6.2	9.2	6.7	5.7	4.3	(7.3)	38

Note: Underlined values exceed 30 day or annual criteria
Annual averages in brackets based on data not representative of complete year

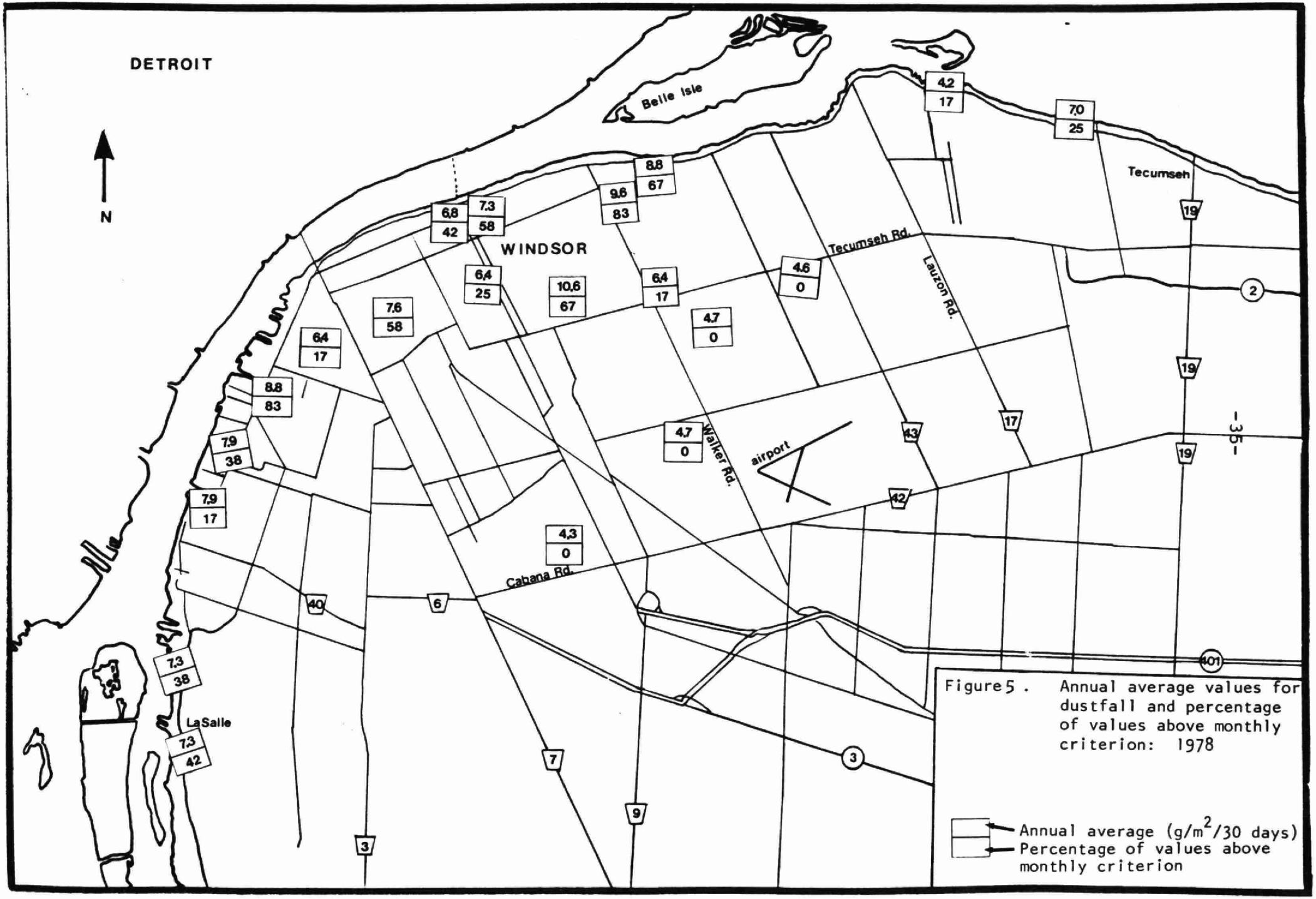
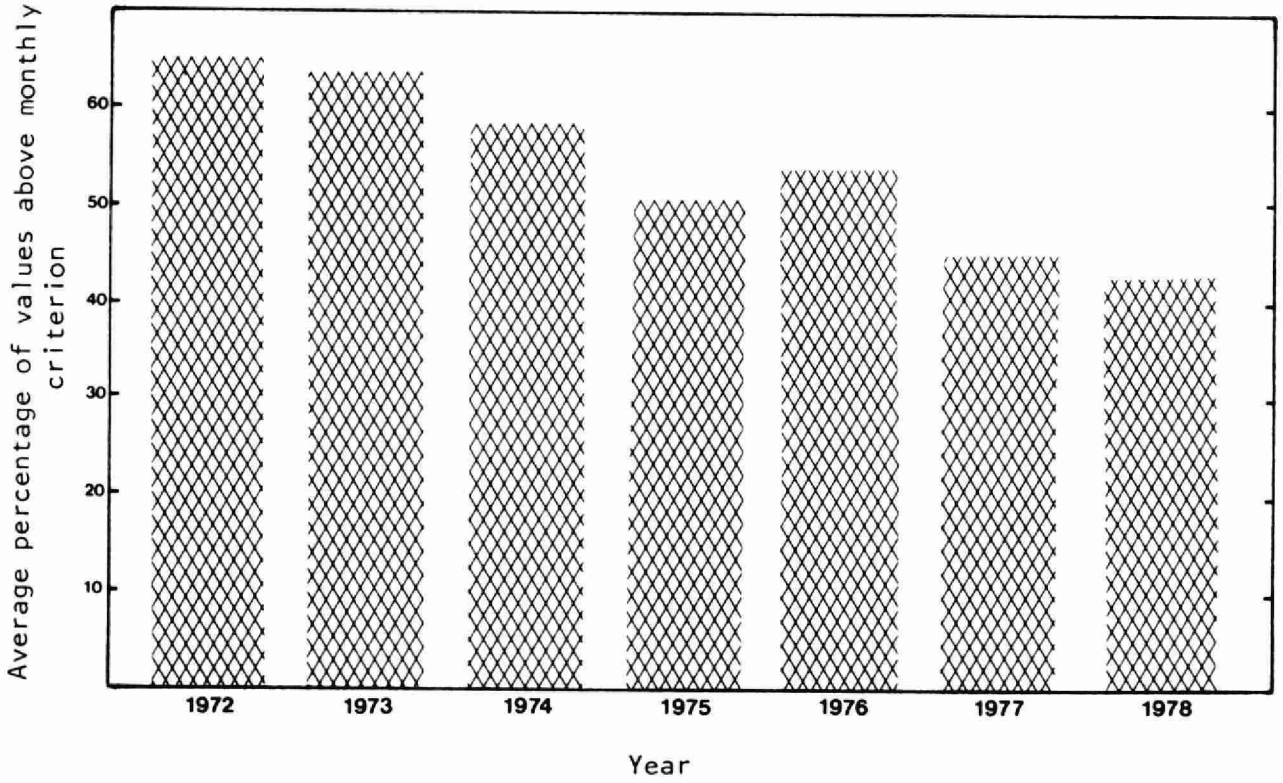
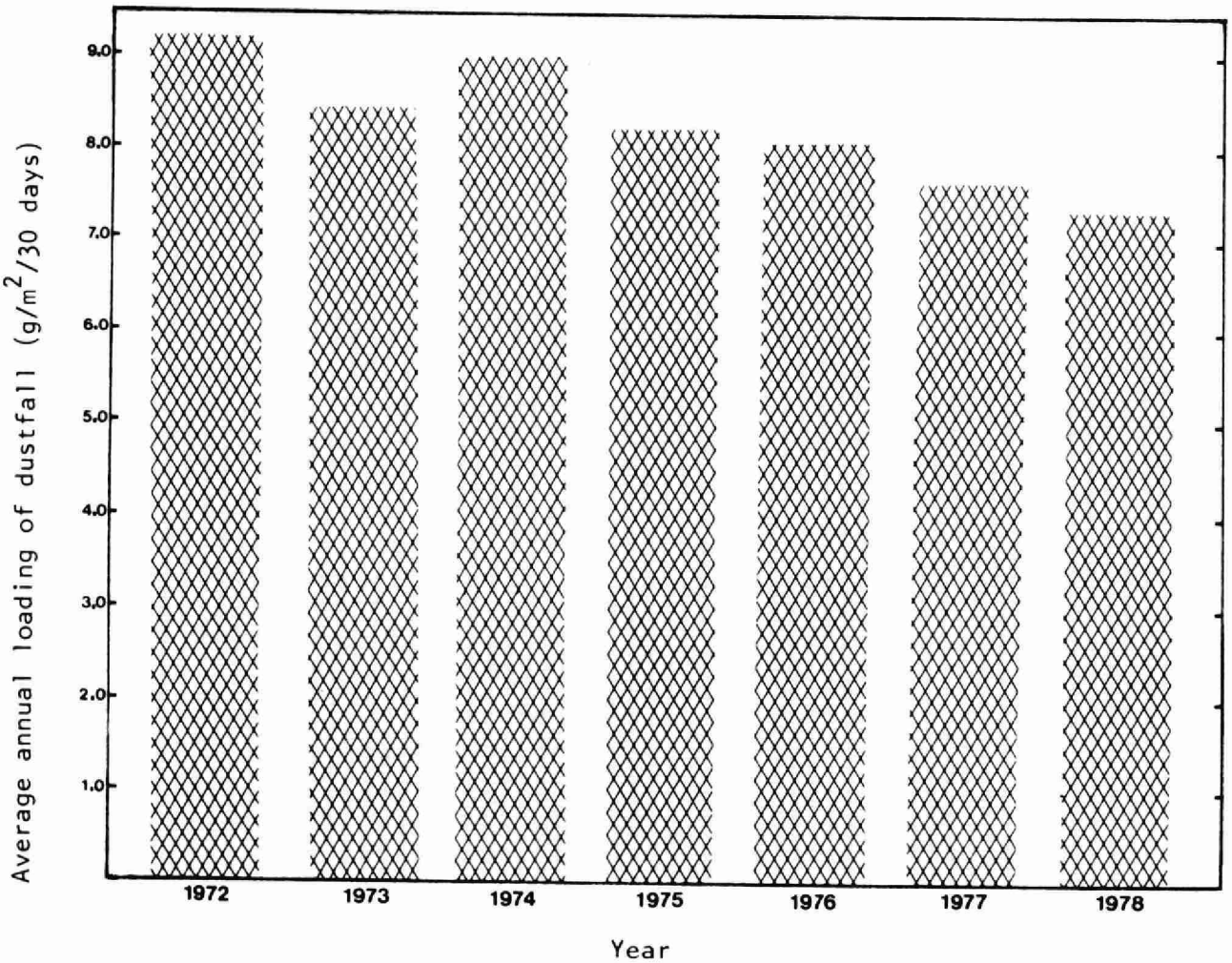


Figure 5. Annual average values for dustfall and percentage of values above monthly criterion: 1978

Annual average (g/m^2/30 days)
Percentage of values above monthly criterion

Figure 6. Trend in dustfall levels based on averaged data for fourteen monitoring stations





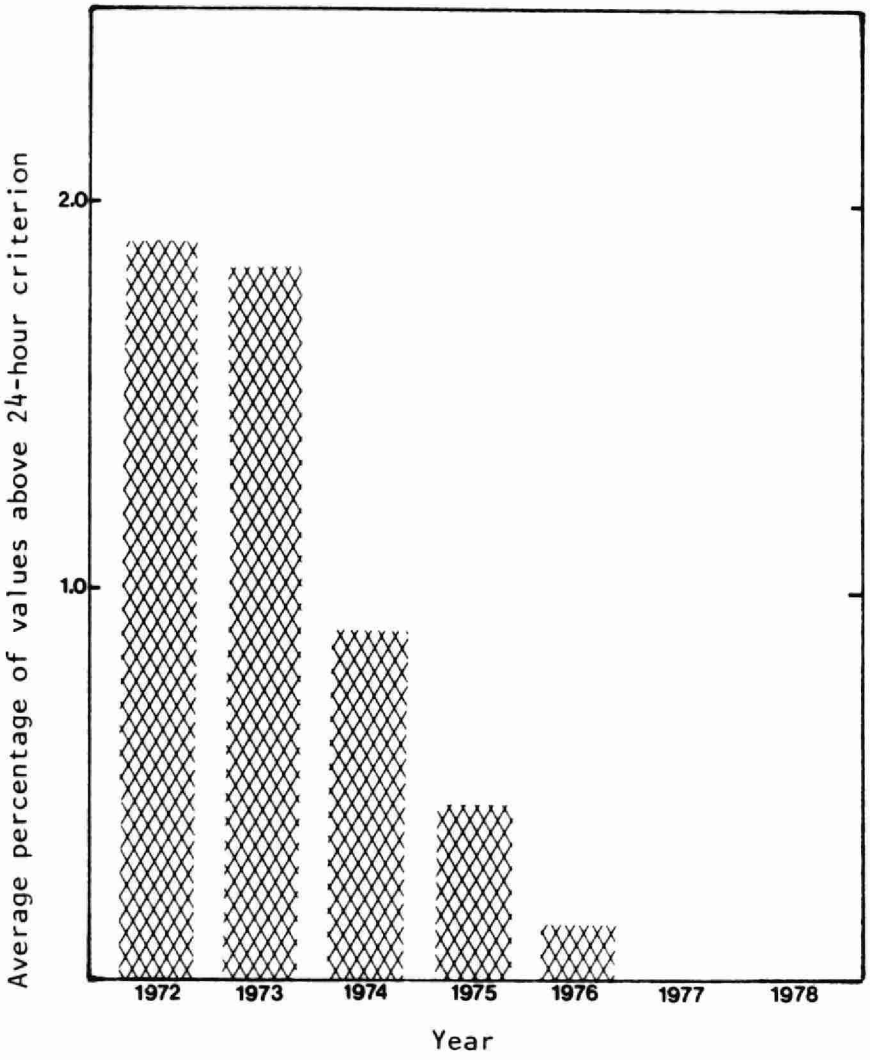
APPENDIX 4

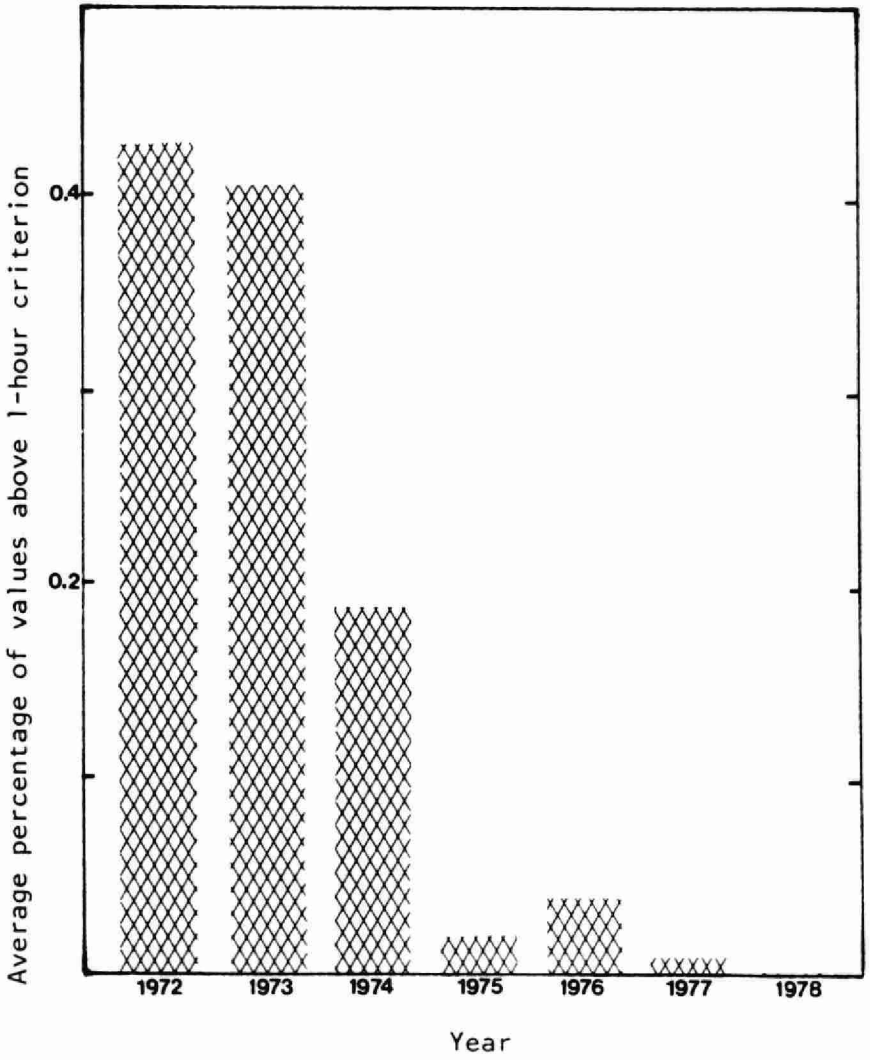
SULPHUR OXIDES

Table 8. Summary of 1978 data for sulphur dioxide

Parameter	Station number				
	12008	12013	12015	12016	12032
Annual average (ppm)	0.02	0.01	0.01	0.01	0.02
Percentage of values greater than:					
1-hour criterion	0	0	0	0	0
24-hour criterion	0	0	0	0	0
Highest 1-hour value (ppm)	0.17	0.12	0.10	0.15	0.12
Highest 24-hour value (ppm)	0.06	0.05	0.04	0.05	0.05

Figure 7. Trend in frequencies of excursions for sulphur dioxide based on combined data from stations 12008 and 12032





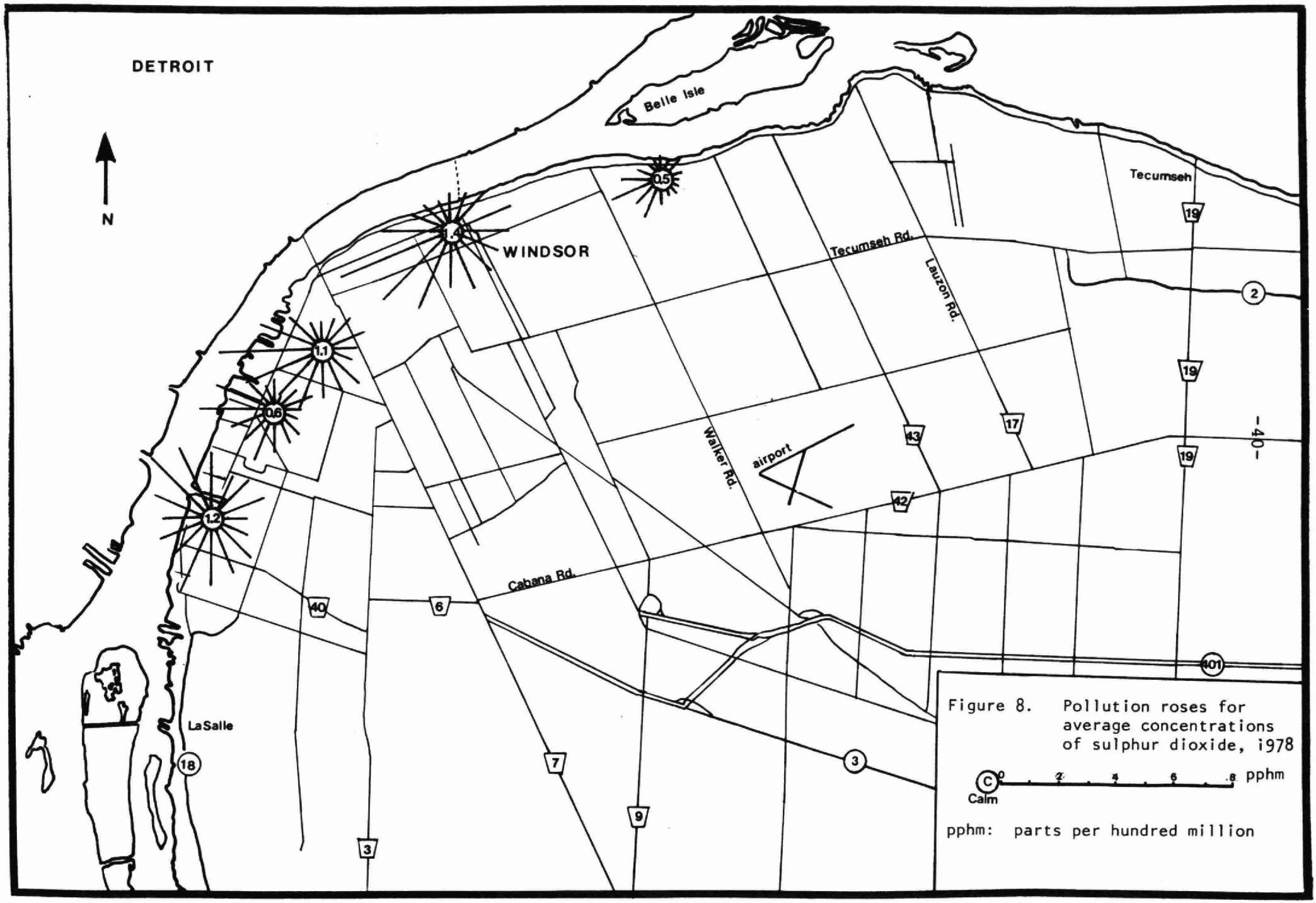

DETROIT
Belle Isle
N
0.5
1.4
WINDSOR
Tecumseh
Tecumseh Rd.
Lauzon Rd.
1.1
0.6
1.2
Walker Rd.
airport
Cabana Rd.
LaSalle
2
19
17
43
42
40
6
7
9
3
18
401
-40-
Figure 8. Pollution roses for average concentrations of sulphur dioxide, 1978
C
Calm
0
2
4
6
8
pphm
pphm: parts per hundred million

Table 9. Levels of sulphation rate during 1978

Station number	Sulphation rate (mg SO_3/100cm^2/day												Annual average	Percentage of values greater than monthly criterion
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec		
12002	0.56	1.75	0.55	0.37	0.42	0.17	0.46	0.56	0.77	0.66	1.30	1.49	0.76	33
12005									0.73	0.80	0.70	1.05	(0.84)	100
12008	-	0.52	0.40	0.30	0.27	0.29	0.29	0.40	0.44	0.37	0.40	0.59	0.36	0
12009	1.11	0.76	0.64	0.51	0.45	0.60	0.39	0.47	0.47	0.55	0.58	-	0.59	18
12010	0.54	0.57	0.61	0.62	0.42	0.36	0.25	0.30	0.31	0.37	0.54	0.52	0.45	0
12012	0.72	0.66	0.60	0.36	0.30								(0.53)	20
12013	1.04	0.69	0.55	0.33	0.46	0.31	0.42	0.53	0.47	0.70	0.53	0.68	0.56	8
12014	0.99	0.83	0.83	0.56	0.57	0.36	0.45	0.61	0.73	0.92	0.82	1.23	0.74	58
12015	1.42	1.14	1.26	0.84	0.83	0.19	0.86	0.97	1.07	1.32	1.24	1.91	1.09	92
12016	0.95	1.17	1.21	0.80	0.80	0.76	0.79	-	1.01	1.08	1.07	1.56	1.02	100
12017	0.95	0.63	0.64	0.51									(0.68)	25
12018	0.86	0.70	0.62										(0.73)	33
12019	0.61	0.65											(0.63)	0
12020	0.73	0.58	0.54	0.43	0.36	0.41	0.35	0.47	0.49	0.52	0.55	0.77	0.52	17
12022	0.88	0.66	0.62	-	0.49	0.58	0.51	0.57	0.64	0.71	0.70	0.82	0.65	27
12024	0.83	0.48	0.48										(0.60)	33
12027	0.75	0.63	0.53	0.43	0.51	0.55	0.44	0.51	0.48	0.70	0.60	0.81	0.58	17
12029	0.87	0.70	0.70	0.56	0.53	0.58	0.59	0.61	0.68	0.70	0.81	1.27	0.72	25
12032	1.05	1.09	0.79	0.70	0.64	0.89	0.59	0.57	0.58	0.87	0.69	0.77	0.77	50
12033	0.96	0.68	0.64	0.53	0.49	0.53	0.40	0.42	0.46	0.54	0.53	0.83	0.58	17
12035	1.33	-	0.94										(1.14)	100
12036				0.33	0.43	0.50	0.48	0.51	0.57	0.77	0.64	0.74	0.55	22
12040	0.92	0.53	0.35	0.39	0.46	0.31	0.29	-	0.46	0.54	0.53	0.69	0.50	9
12041	0.86	0.49	0.32										(0.56)	33
12042				0.36	0.43	0.46	0.43	0.43	0.42	0.59	0.54	0.67	0.48	0
12043				0.55	0.36	0.46	0.36	0.39	0.38	0.51	0.54	0.79	0.48	11
12044				0.43	0.43	0.51	0.38	-	0.39	0.45	0.46	0.71	0.47	13
12045				0.73	0.72	1.00	0.67	0.82	0.65	1.29	0.85	1.26	0.89	78
12046				0.49	0.58	0.53	0.36	0.44	0.49	0.69	0.56	0.85	0.55	11

Note: Underlined values exceed criterion. Bracketed values are averages of data not representative of year

APPENDIX 5

CARBON MONOXIDE, OXIDES OF NITROGEN

TOTAL HYDROCARBONS AND OZONE

Table 10. Summary of data for carbon monoxide, oxides of nitrogen, total hydrocarbons and ozone

Parameter	1978	1977	1976	1975	1974	1973	1972
Carbon monoxide							
Annual average (ppm)	2	2	4	5	5	5	5
Percentage of values greater than:							
1-hour criterion	0	0	0	0	0	0.01	0
8-hour criterion	0	0	0	0.32	0.30	0.10	0
Nitrogen Dioxide							
Annual average (ppm)	0.04	0.03	0.03	0.03	0.03		
Percentage of values greater than:							
1-hour criterion	0.01	0	0	0	0		
24-hour criterion	0	0	0	0	0		
Nitric oxide							
Annual average (ppm)	0.03	0.03	0.03	0.03	0.04		
Total oxides of nitrogen							
Annual average (ppm)	0.07	0.07	0.06	0.06	0.07		
Total hydrocarbons							
Annual average (ppm)	2.3	2.4	2.6	2.2	1.9	2.1	2.2
Ozone							
Annual average (ppm)	0.018	0.021	0.021	0.017	0.014		
Percentage of values greater than:							
1-hour criterion	2.4	3.1	2.5	2.2	0.8		

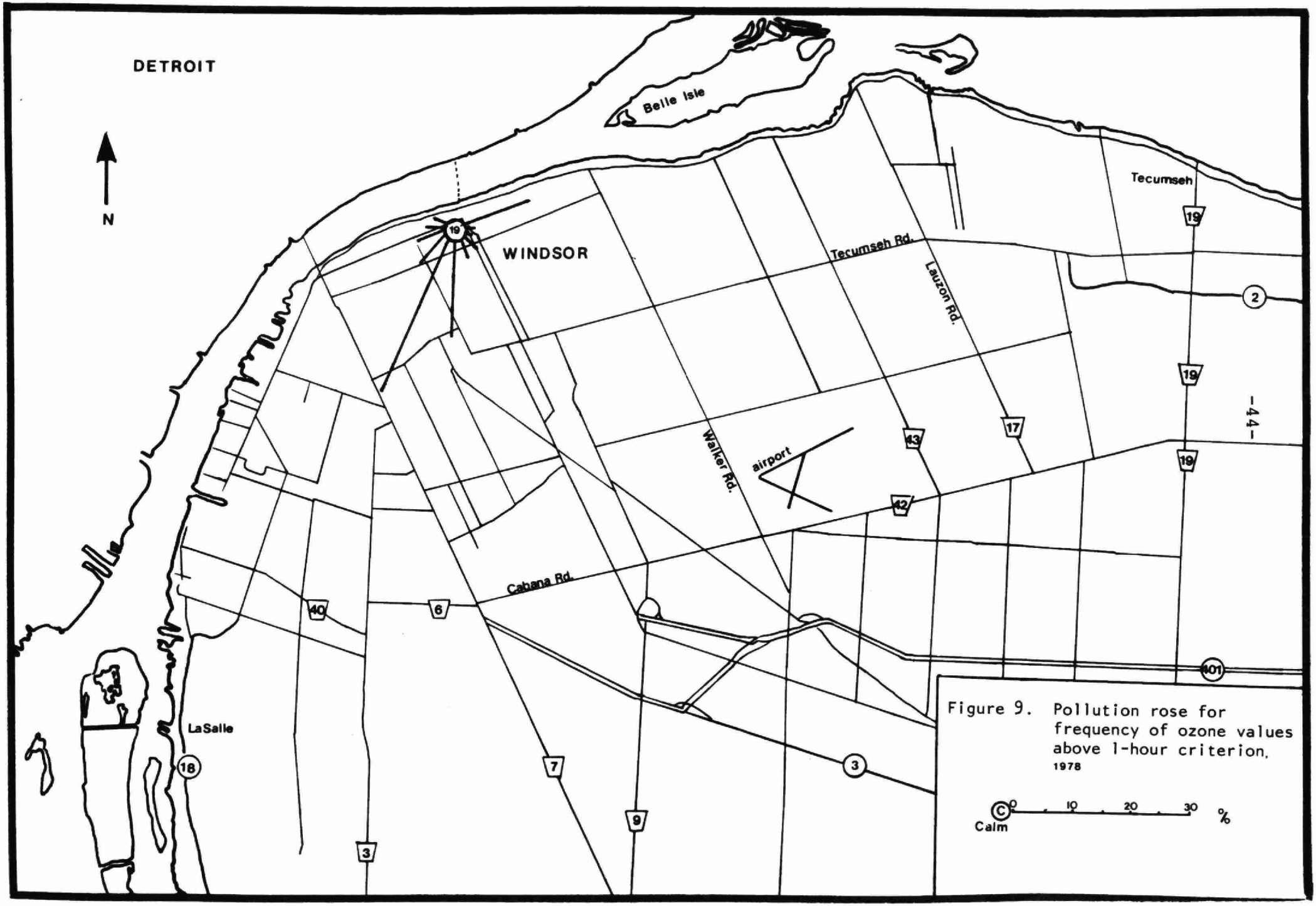


Figure 9. Pollution rose for frequency of ozone values above 1-hour criterion, 1978

APPENDIX 6

FLUORIDATION RATE

Table 11. Levels of fluoridation rate during 1978

Station number	Fluoridation rate (ugF/100 cm^2/30 days)													
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual average	Percentage of values greater than criteria
12008	46	53	39	25	25	39	40	43	48	55	42	56	43	17
12015	71	46	67	31	32	57	33	60	59	29	48	71	50	25
12016	70	51	64	30	34	48	39	56	50	46	54	63	50	25
12022	41	34	43	25	26	33	30	45	37	34	31	33	34	8
12027	29	31	31	16	20	31	30	34	30	29	22	30	28	0
12032	98	59	56	54	47	57	62	57	49	51	63	70	60	50
12035	49	40	52										(47)	0
12040	48	38	27		24	24	23	28	35	40	22	31	31	0
12045				23	32	35	35	41	31	51	45	75	(41)	11

Note: 1. Underlined values exceed criteria for desirable ambient air
2. Averages in brackets based on data not representatvie of year

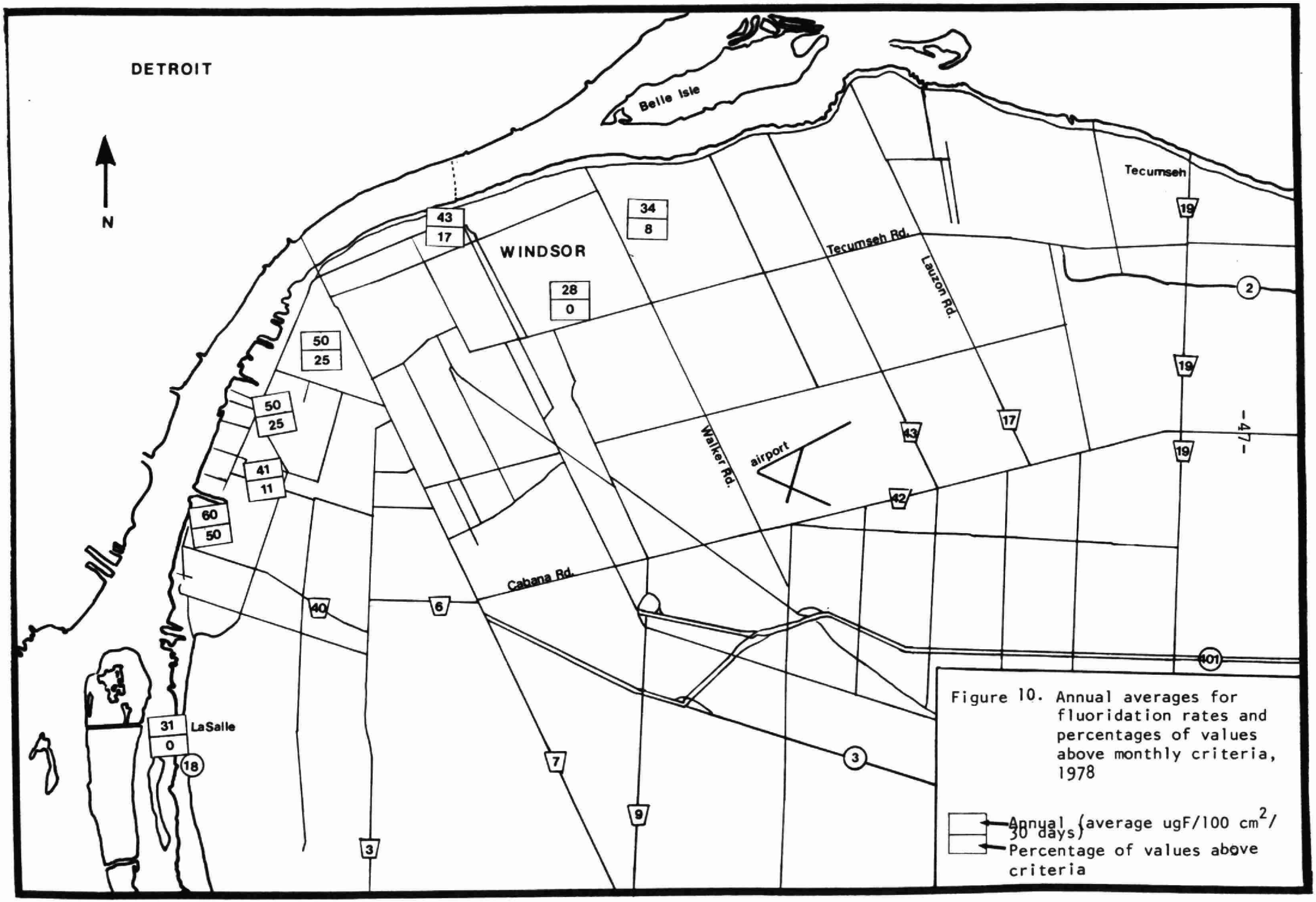


Figure 10. Annual averages for fluoridation rates and percentages of values above monthly criteria, 1978

Annual (average ugF/100 cm^2/ 30 days)

Percentage of values above criteria

Figure 11. Trend in levels of fluoridation rates based on averaged data for six monitoring stations